

STATE OF HAWAII
GEOTHERMAL ACTION PLAN
ELEMENT II

REVIEW OF EMERGENCY PLAN AND RESPONSE TO THE
12 JUNE 1991 UNCONTROLLED VENTING OF THE
PUNA GEOTHERMAL VENTURES (PGV) KS8
GEOTHERMAL WELL

SUBMITTED TO: The Honorable Lorraine R. Inouye
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EXECUTIVE SUMMARY

The actual implementation of the PGV Emergency Response Plan went reasonably well. Concern from fire and police personnel over health risks and confusion on the part of citizens over how to proceed during the on and off again alert notification in the Leilani Estates Subdivision were a cause for some difficulty during the response. Confusion over the applicability of temporary housing cost reimbursement in relation to the 3,500 feet perimeter and the function of the PGV Employee Alarm System also served to exacerbate the stressful nature of the emergency response to the blow out. Nonetheless, the evacuation and alert were successful.

Based on the experience of the 12 June 1991 upset incident, the PGV Emergency Response Plan should be reviewed and revised appropriately. Such a review should henceforth be conducted annually, along with exercising the plan.

The Pahoia Community needs to understand how these issues are resolved so there is no confusion in the event of another upset. Emergency air monitoring, concern over emergency H₂S action levels and PGV emergency notification are other areas that require review and improvement.

The following summary recommendations are provided based upon a preliminary review of the 12 June 1991, response to the PGV well blow out:

1. The Department of Health (DOH) should complete a revised analysis of the hazard of an uncontrolled venting of the PGV Well.
2. DOH should complete a health review of the warning, alert, and emergency action levels for H₂S.
3. DOH should complete a review of H₂S monitoring capability and procedures for upset conditions.
4. Upon completion of 1 through 3 of the above, the Hawaii State Emergency Response Commission and Hawaii County Local Emergency Planning Committee should review, revise and exercise the PGV Emergency Response Plan.
5. The Hawaii County Planning Department should resolve confusion over housing reimbursement and the function of the PGV employee alarm system.
6. PGV should review notification procedures and provide appropriate verbal and written notification to ensure compliance with the Emergency Planning and Community Right-to-Know Act of 1986.

I. BACKGROUND

In July of 1990, after seven months of review, the Emergency Response Plan for the Puna Geothermal Venture (PGV) 25 MW Power Project Geothermal Resource Permit: GRP 87-2 was accepted by Hawaii County and Hawaii State government agencies to fulfill permit requirements. Approximately one year later at 11:06 p.m. on 12 June 1991, an uncontrolled flow event at the PGV Well activated the Emergency Response Plan. During the approximately 31 hours of the release, PGV, County and State agencies, and volunteer organizations worked with citizens to respond to the release, evacuate households in the Lani Puna Gardens, alert residents in the Leilani Estates Subdivision and, provide shelter and security, while the release was being brought under control.

Another important factor in the response was conflicting information that may have caused confusion. During and after the response, questions by citizens were raised over reimbursable costs for emergency response, the function of the PGV alarm, and the general applicability of the 3,500 foot perimeter as defined in the Geothermal permit, and other issues that relate to this incident. For example, under the permit, PGV is required to reimburse community members that must be relocated for a controlled venting if they are within the 3,500 foot perimeter. PGV is not required to reimburse community members for relocation costs for uncontrolled venting during emergencies, etc.

PGV has an employee alarm system at their facility for their own emergency use. The alarm is not meant to be used by citizens for their notification purposes. Nonetheless, a number of citizens have expressed concerns that they did not believe that the alarm system worked properly so that they were notified of the emergency. Other citizens have noted that PGV did not use the alarm in all events when they should have.

Finally it should be noted that the PGV Emergency Plan had never been exercised and this is the first time a geothermal release has prompted an evacuation in Hawaii. Therefore, this is the first time the emergency response plan has been evaluated based on an exercise or an actual experience and affords an opportunity for PGV Emergency Response Plan improvement.

II. REVIEW OF RESPONSE AND DISCUSSION

A. Sequence of Events

A brief review of the essential sequence of events that occurred during the response is included in Appendix I. It is not complete, but provides a general outline of

the key events that occurred. A summary of Appendix I is provided below.

Wednesday, 12 June 1991

- . At 23:06 PGV reports the well blow out occurred. At 23:15 a citizen notified Hawaii Fire Department (HFD) of a possible Geothermal venting or upset event. HFD immediately notified Hawaii Civil Defense (HCD). PGV contacted HCD at 23:25. At 23:34 PGV requested HFD provide an ambulance for two minor injuries. At 23:45 Hawaii Police Department (HPD) reported a 60 foot steam cloud from the Well, wind coming from the southeast and headed for the Pohiki area.
- . At 23:30 HPD arrived on-scene at the pre-designated command post, a third of a mile east of the Well head.
- . At 23:55 HCD requested Department of Health (DOH) hydrogen sulfide (H₂S) monitoring support. DOH estimated a time of arrival to the command post at 01:30.

Thursday, 13 June 1991

- . At 00:10 HPD commenced evacuation of Lani Puna Gardens based on recommendation by PGV. HFD noted that they were not notified of this event. HCD noted that this was due in part to the fact that the evacuation was for a small number of households (5).
- . At 00:50 HCD contacted HFD at the Emergency Operations Center, Hawaii Civil Defense Agency, Hilo, Hawaii.
- . At 00:50 HCD contacted the Red Cross to open the shelter at the Pahoa Community Center based on the Lani Puna evacuation.
- . At 01:00 PGV reported first monitoring data just outside the fence line of the perimeter of the well site, 20 parts per million (ppm) of H₂S, and a second reading 29 ppm of H₂S.
- . At 01:10, DOH monitoring staff contacted the Deputy Director for Environmental Health, who recommended proposed H₂S action levels be used as guidance in protecting public health. It was recommended that the residents be relocated if H₂S levels are likely to exceed 10 ppm as a one hour average.

- . At 01:25 DOH monitoring from Lanipuna Street reported less than .5 ppm H₂S (the limit of detection for the Dreager tube being used).
- . At 01:13 a house-to-house alert was initiated by HFD as requested by HCD. This alert was for the 230 homes in the Leilani Estates Subdivision. These are approximately one-acre lots and the houses are spread far apart, therefore it took a substantial amount of time to notify each household.
- . At 01:30 the Red Cross reported that the Pahoa Neighborhood Center Shelter was open and, at 01:37 roadblocks were established by HPD at three points to control traffic near the effected area.
- . At 02:15 HCD requested HFD to stop the house-to-house alerts in the Leilani Estates Subdivision. This decision was based on the determination that the situation required reevaluation and a review and coordination of the alert message that was being provided to the Leilani Estates Subdivision residents by HFD.
- . At 05:00 HCD notified all radio stations of the Alert Advisory Status of surrounding residential areas for any individuals that may be experiencing any unacceptable nuisance or health effects from the release and that persons should report to the Pahoa Neighborhood Center. A copy of the announcement is attached in Appendix B. At 05:15 HCD, based on their reevaluation, determined that the uncontrolled venting would be prolonged and that the house-to-house alert should be continued. At 09:15 the house-to-house alert was completed.

Friday, 14 June 1991

- . At 06:30, PGV reports the well had been shut in.

B. Release Notification

At 23:06 PGV reports that the uncontrolled flow event began. PGV then notified HCD at 23:25. Therefore, estimated time required for PGV to notify response authorities initially was approximately 19 minutes. During this time, PGV reports that they were moving injured workers away from the drilling rig and securing the immediate area around the rig.

Notification of releases of H₂S above the reportable quantity (RQ) of 100 pounds in a 24-hour period should be provided to the National Response Center (NRC), State Emergency Response Commission (SERC), and the Local

Emergency Planning Committee (LEPC) under Section 304, Emergency Planning and Community Right-to-Know Act of 1986. By contacting HCD, PGV met notification for the LEPC. PGV requested HCD to contact DOH in order to comply with requirements for State Emergency Response Commission notification. PGV did not notify the NRC. As of 22 June 1991, the State Emergency Response Commission did not receive a written follow up notification of the H₂S release.

The release of H₂S most likely exceeded the RQ.

C. Site Response By PGV

PGV secured the site and only allowed authorized personnel to enter the site. PGV's site response based on limited information appears to have been conducted appropriately, at least in regards to security and coordination with agency personnel. Further evaluation of alternative technologies to control a well kick, and well venting in the event of an uncontrolled release should be conducted and is being pursued concurrently by a state funded team of experts.

It should be noted that for a certain period of time it has been reported that in order to control the well, the venting was directed horizontally, instead of vertically. Therefore, based on the PGV site response, a hazard analysis should include horizontal, as well as, vertical venting to determine more accurately the potential of H₂S concentrations that might be generated in the surrounding community from such a release.

HFD expressed concerns over the possible need for a rescue of injured personnel during a well head venting if a PGV rescue could not be conducted. Potential for personal protection equipment contamination from well steam indicates decontamination for first responders is also an issue. These concerns should be investigated further to determine the likelihood of this occurring, and appropriate planning completed based on this analysis.

D. Agency Notification

As described in Appendix I, it appears agency notification worked exceptionally well for this response, in that, HCD, HPD, HFD, DOH, and ARC were immediately notified in a timely manner and, based on distances to be traveled, responded to the appropriate locations in a timely fashion.

E. Public Alert Notification and Evacuation

Generally, public notification went well.

The high H₂S (20 and 29 ppm) concentrations reported at 01:00 supported HCD's decision to initiate alert notification procedures for residents in Leilani Estates. HFD implemented the alert notification in Leilani Estates 13 minutes after the HCD request. Eleven minutes later, at 01:25 DOH reported less than .5 ppm H₂S on Lanipuna Street. It appears that H₂S concentrations may have declined rapidly after the initial release.

Subsequent to the incident, citizens expressed concern over confusion as to exactly what was happening and where they should have been directed. Review of the verbal message provided by HFD staff conducting the house to house evacuation indicates that the reports were clear and appropriate.

Since the alert advisory of Leilani Estates was initiated at 01:13 it appears that the radio stations should have been notified of the advisory at this time. This may have reduced the amount of citizen confusion. At 05:00 HCD notified the radio stations of the evacuation.

The on again, off again nature of the alert advisory probably caused some confusion on the part of citizens. The alert was suspended from 02:15 to 05:15, a total of two hours. It should also be noted that HFD and HPD personnel expressed concerns about their potential exposure to H₂S during the evacuation and alert notification process.

The actual evacuation and sheltering was executed in a reasonable manner and was generally successful. American Red Cross personnel noted along with police and fire, that the persons that reported to the shelter had expectations for better provisions for the evacuees, such as blankets, ear protection, funds for temporary housing costs, and other support would be provided on-scene. Such arrangements had not been made. It should be noted that nationally, and in Hawaii such prearranged evacuation supplies are not stock piled at predetermined evacuation shelters due to the cost and the difficulty of knowing where an appropriate shelter location might be.

It appears that there is a variety of opinion on what should be provided to the citizens in the event of an evacuation caused by a uncontrolled geothermal venting release.

In addition, confusion on the part of many citizens as to what they are entitled to regarding reimbursement for cost associated with geothermal evacuation also led to high expectations.

PGV is not required to reimburse Hawaii County for emergency response costs in the event of an uncontrolled well venting. During the emergency, PGV was approached by a limited number of citizens at the command post for assistance in temporary housing costs because citizens needed money in order to rent hotels, etc. PGV did provide certain individuals with money so they could relocate during the emergency. This may have caused confusion because PGV provided funds for temporary housing costs despite the fact that they were not required to under the permit.

F. Emergency Air Quality Monitoring

Interviews and reviews of emergency monitoring data indicates that government emergency response monitoring capability is currently insufficient. In addition, health, police, and fire personnel indicated some uncertainty in understanding of H₂S hazards and methods for monitoring and detection.

DOH monitoring with Draeger Colormetric Tubes and utilizing a portable Colortec monitor were not completely sufficient for emergency response needs. Because of the stationary nature of the ambient air quality monitoring stations, these instruments can be considered supplemental to portable emergency response monitoring instruments.

A separate element of the review of this incident will evaluate the adequacy of the air and noise monitoring program.

There was a substantial delay between the original notification of the release at 23:25 and the first report of monitoring results at 01:00. Along with immediate health and safety issues monitoring should have been initiated and results reported in a timely fashion since H₂S monitoring is also an immediate health and safety issue when an upset condition occurs.

PGV monitoring was provided using a Jerome 631x monitoring unit which provides real time digital read out of H₂S concentrations. Real Time digital readout monitoring is more appropriate for emergency response needs and can be supplemented by an alarm type monitor that can be triggered if concentrations exceed a predetermined level. More appropriate monitoring instrumentation should be provided to health and fire

personnel. Special consideration should be made for community wide DOH monitoring needs versus site entry, rescue, and safety monitoring needs of HFD.

G. Adequacy of Department of Health Alert, Warning and Emergency Action Level

It appears that there is still some concern as to the adequacy of the currently established Alert, Warning and Emergency Action Levels for H₂S as established under the PGV permit and included in the PGV emergency response plan.

Agency personnel as well as, many citizens certainly experienced a substantial nuisance from low concentrations of H₂S. Based on health effects reported, including headache, nausea, dizziness, respiratory irritation, and others, a re-evaluation of the emergency levels is indicated. It is important to note that well noise, stress caused by the incident, along with other pollutants in the venting steam may have contributed to the effect sensitive persons may have experienced from H₂S exposure.

It was reported that one police officer out of the four involved in the evacuation became ill from exposure to H₂S and therefore had to be pulled back from implementing the Lani Puna Gardens evacuation. Sensitive individuals have to be considered in the implementation of evacuation and the establishment of action levels.

H. Community Relations and Emergency Preparedness

Community relations is important in regards to the execution of an emergency response. Citizen cooperation and understanding is essential if a proper and efficient emergency response is to be implemented. Many citizens as well as agency personnel were confused the night of the emergency. This confusion would be minimized through a better understanding of the policies and procedures relating to the emergency response plan. Increased communication between PGV citizens and state and county agencies and non-profit agencies is required in order to improve the response. It should be noted that the Hawaii Planning Department did make the PGV Emergency Plan available for public review.

III. CONCLUSIONS

This limited evaluation identified a number of areas for response improvement. Other issues require further studies or a long term evaluation.

A fundamental element of a complete evaluation is a careful analysis of the actual concentrations of H₂S reported through out the PGV area and the surrounding community during the upset conditions compared to the modelled concentrations that were predicted in the emergency response plan. Generally, based on a preliminary evaluation of the data the concentrations of H₂S throughout the community were within the ranges of modelled or predicted values estimated in the hazard evaluation portion of the PGV Emergency Response plan. One exception stands out and that is the reported 22 and 29 ppm concentrations at the fence perimeter of the PGV facility.

Those high numbers supported the determination to follow through on the evacuation of Lani Puna Gardens, although the evacuation was initiated before monitoring results were received by HCD. It can not be assumed that the monitoring capability generally available in an emergency response will capture the highest concentrations of contaminants that actually occur during an emergency. This must be considered for planning, and response purposes.

Further investigation of monitoring data is required, and has already been initiated as a special study review of actual recorded data during the event, along with micrometeorological and aerometric analysis of the area surrounding the PGV facility.

This re-evaluation of the hazard may require a revision to the estimated hazard posed by a free flow venting of the well. A hazard analysis determines how an emergency response plan should be written and what resources should be prestaged for response and mitigation. Based on a revised hazard analysis, using all available information, the plan should be reviewed and revised appropriately. A review and if necessary revision of the plan along with exercising should be an annual activity in order to keep the plan operational and effective.

Emergency response monitoring capabilities need to be substantially upgraded. DOH and HFD personnel should be equipped to provide real time monitoring for their emergency response purposes. Redundancy in capability is required. PGV should establish procedures to begin monitoring and report results in a more timely fashion. The procedures should be addressed in the PGV plan. A separate study currently under way evaluating monitoring capability should expand on this issue and provide details on adequate monitoring capability.

PGV should evaluate its response capability for uncontrolled venting and should include capability to prevent and control any upset condition. PGV exceeded the RQ for H₂S under Section 304 of the Emergency Planning and Community Right-

to-Know Act of 1986, and should complete additional notification as required. PGV notification procedures should be reviewed and revised to ensure complete and timely direct notification to all appropriate agencies.

If possible, public notification of an evacuation by radio should complement the timing for evacuations. This could serve to reduce confusion for evacuees, although awakening in the middle of a deep sleep to receive an evacuation or alert notice can be a cause of confusion in itself.

A complete review of the Alert Warning and Emergency Action Levels should be conducted by the DOH. Special consideration of low level nuisance effects on sensitive individuals is required. Upon completion of DOH's review of response levels, county and citizen representatives should be informed of DOH's findings and training provided to review how the levels should be used.

The actual implementation of the PGV Emergency Response Plan went reasonably well. Concern from fire and police personnel over health risks and confusion on the part of citizens over how to proceed during the on and off again alert notification in the Leilani Estates Subdivision were a cause for some difficulty during the response. Nonetheless, the evacuation and alert were successful. Based on the experience of the 12 June 1991 upset incident, the PGV Emergency Response Plan should be reviewed and revised appropriately. Such a review should henceforth be conducted annually, along with exercising the plan.

Confusion over the applicability of temporary housing cost reimbursement in relation to the 3,500 feet perimeter and the function of the PGV Employee Alarm System also served to exacerbate the stressful nature of the emergency response to the blow out. The purpose of these provisions in the permit should be revisited by the County Planning Department's committee that originally reviewed these issues. The Pahoa Community needs to understand how these issues are resolved so there is no confusion in the event of another upset.

The expectation of free hotel housing for some of the citizens may have played a role in the way the American Red Cross Shelter was received. Some individuals were expecting more than the standard, basic support than was provided at the Puna Neighborhood Center, and is provided nationally.

The following recommendations should provide a framework to improve the PGV Emergency Response Plan, reduce difficulties, and create a means for the public and private agencies, citizens and PGV to be better prepared for a well upset.

IV. SUMMARY OF RECOMMENDATIONS

- A. DOH Should Complete a Revised Analysis of the Hazard of an Uncontrolled Venting of the PGV Well.

All emergency response H₂S monitoring data should be compiled and reviewed, and compared to initial modeling data. An analysis of the predicted H₂S hazard based upon the results of the actual field monitoring data should be used to complete a revised hazard analysis. The revised hazard analysis should be included in the PGV Emergency Response Plan. The analysis should address horizontal venting. This recommendation has already been initiated simultaneous to this emergency response review.

- B. DOH Should Complete a Health Review of the Warning, Alert and Emergency Action Levels for H₂S.

The Warning, Alert and Emergency Levels for H₂S should be re-evaluated for their adequacy, particularly as they relate to nuisance levels and sensitive individuals. Other stressors such as noise, stress from the emergency and other pollutants in the well steam should be included in the review. A review and training on these and other pertinent levels should be provided to appropriate agencies. The review should also address the need for HFD rescue backup for PGV workers at the well site, and decontamination issues in the event of an HFD site entry.

- C. DOH Should Complete a Review of H₂S Monitoring Capability and Procedures for Upset Conditions.

Emergency H₂S monitoring capability and procedures for county, state, and PGV should be reviewed, upgraded and revised as appropriate. This recommendation has already been initiated simultaneous to this emergency response review. Timeliness of PGV monitoring at the site should be addressed. Specific monitoring needs of DOH and HFD should be considered

- D. The Hawaii State Emergency Response Commission and the Hawaii County Local Emergency Response Commission Should Review, Revise and Exercise the PGV Emergency Response Plan.

The PGV Emergency Response Plan, should be revised based upon 1-3 above. The plan should be updated by PGV and submitted to the Hawaii State Emergency Response Commission and the Hawaii Local Emergency Planning Committee on an annual basis. The plan should be exercised annually.

- E. The Hawaii County Department of Planning Should Resolve Confusion Over Housing Reimbursement and the Function of the PGV Employee Alarm System.

The Hawaii County Department of Planning through its original committee that included community representation should revisit temporary housing cost reimbursement issues, the use of the PGV employee alarm system and applicability of the 3,500 perimeter as they pertain to the PGV permit. An effective education and information effort should be conducted to ensure the Pahoa community is aware of the final outcome of this review.

- F. PGV Should Review Notification Procedures and Provide Appropriate Verbal and Written Notification to Ensure Compliance with the Emergency Planning and Community Right-to-Know Act of 1986.

Amounts of H₂S released from the PGV well most likely exceeded the reportable quantity of 100 pounds which requires mandatory reporting. To ensure compliance, PGV should provide verbal and written notification to the appropriate agencies for this and any future upset conditions.

References

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- U.S. Environmental Protection Agency, Federal Emergency Management Agency, U.S. Department of Transportation (1987) Technical Guidance for Hazards Analysis: Emergency Planning for Extremely Hazardous Substances.
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- U.S. Environmental Protection Agency, Review of Emergency Systems, Report to Congress, Section 305(b) Title III Superfund Amendments and Reauthorization Act of 1986. June 1988.
- Kizis, Thomas G. Report on Uncontrolled Flow Event as Per Conditions, #13 and #26. ATC No. A-833-795, Attachment II, Wellfield, June 17, 1991.

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APPENDIX I
Sequence of Events of 12 June 1991
Uncontrolled Geothermal Venting

TIME/DATE	ACTION/EVENT
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Wednesday, 12 June 1991

23:06	Well Blow out occurred.
23:15	Public notified Hawaii Fire Department (HFD) of possible Geothermal venting.
23:17	HFD notified Hawaii Civil Defense (HCD).
23:25	PGV notified HCD; HCD called out CD4.
23:30	HPD arrived on scene.
23:34	Puna Geothermal Venture Requested HFD for ambulance for two minor injuries at PGV. Meanwhile Hawaii Fire Department (HFD) arrives on scene.
23:35	HCD activated Emergency Operating Center (EOC). Opened operations in Hilo office.
23:36	HCD CD dispatched staff to predesignated command post.
23:40	HPD-Puna reported major blowout with steam cloud 60 feet high.
23:45	PGV reported 60 feet steam cloud from well, southeast winds headed toward Pohiki.
23:55	HCD requested Department of Health (DOH) monitoring support. DOH reports estimated time of arrival at command post of 01:30. HCD also requested another DOH personnel to report to the EOC.

Thursday, 13 June 1991

00:10	Police commenced evacuation of Lani Puna Gardens based on PGV recommendation.
00:30	HCD arrives on scene brief by PGV, no H ₂ S, monitoring data reported from PGV.

00:50 HCD requested American Red Cross (ARC) to open Pahoa Neighbor Center (PNC) for temporary sheltering.

01:00 PGV reports first monitoring data from just outside fence line perimeter at well site. First reading 20ppm H₂S, second reading 29ppm. PGV requests HCD to notify DOH to meet notification requirements.

01:10 DOH monitoring staff contacts Deputy Director for Environmental Health who recommends proposed action levels by used as guidance to protect public health. Residents should be relocated if H₂S levels exceed 10ppm one hour average.

01:13 House to house "Alert Status" notification of the Leilani Estate Subdivision was initiated by HFD as requested by HCD.

01:25 DOH monitoring from Lanipuna Street reports less than .5ppm H₂S.

01:30 ARC reported shelter open at PNC; Fifty citizens registered. All agencies represented at the HCD EOC.

01:37 Road blocks securing the PGV well established by HPD at three points on request by CD.

02:15 HCD requests HFD to stop house to house alert in Leilani Estates Subdivision.

05:00 HCD notified all radio stations there was a voluntary evacuation notification and that persons should report to the PNC.

05:15 HCD determined the release would be prolonged and that the house to house alert should be continued.

09:15 HFD completed the house to house alert of Leilani Estates Subdivision is completed.

Friday, 14 June 1991

06:30 PGV reports well is shut in.